Saskatchewan
Environment

Hydrology Branch

Crane Lake Basin Water Supply Study

March, 1984
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CRANE LAKE BASIN

WATER SUPPLY STUDY

Report No. HYD-3-4

Prepared by:
N. Wyngaarden, P. Eng.
Investigations Division
Hydrology Branch
Saskatchewan Environment

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SYNOPSIS

The Crane Lake Basin is a closed drainage basin located in southwest Saskatchewan. Crane Lake, the terminus of the basin, is fed mainly by flows coming from Piapot and Bear Creeks which have their headwaters on the northern slopes of the Cypress Hills.

The Crane Lake Basin is extensively developed for water use for irrigation purposes, particularly in the upper portions of the basin. This report describes the methodology and results of a water supply study undertaken to evaluate the ability of the Crane Lake Basin to meet existing and future water demands.

The results show that major portions of the basin are over-allocated or nearing complete allocation.

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CHAPTER I

INTRODUCTION

A. GENERAL

The Crane Lake Basin is located in southwestern Saskatchewan as shown on Figure 1, and drains the north slope of the Cypress Hills. The drainage basin covers an area of approximately 870 km^2 and lies within an area bounded by Townships 9 and 13 and Ranges 22 and 25 as shown on Figure 2. The main urban centre within the drainage basin is the Town of Piapot.

The main drainage is from the north slope of the Cypress Hills northward, with Piapot Creek and Bear Creek as the main streams. Bear Creek joins Piapot Creek at the Town of Piapot and then drains into Crane Lake. Crane Lake is the terminus of the drainage basin since it is a closed drainage basin. All water reaching Crane Lake either evaporates or infiltrates into the ground.

The south end of the Crane Lake Basin is characterized by the steep slopes of the Cypress Hills. As the streams proceed northward the slopes flatten out onto the prairie just south of the Town of Piapot. As the streams reach the prairie, sloughs become more prominent, indicating that the natural drainage systems are less well defined. The north end of the basin is bounded by the Great Sand Hills.

Developments in the Crane Lake Basin for water uses date back to the late 1800s. Presently, the basin is developed extensively for irrigation purposes, although numerous licences and authorizations are for domestic purposes as well. It is this extensive development, particularly in the upper portions of the basin, that prompted the Water Rights Branch of Saskatchewan Environment to request a water supply study to evaluate the ability of the Crane Lake Basin to meet existing and future water demands.

B. PURPOSE

The purpose of this study is to evaluate the water supply of the Crane Lake Basin to facilitate the efficient management of the water resources within the basin and to determine the water supply available to meet existing and future demands.

C. TERMS OF REFERENCE

The terms of reference agreed upon by the Hydrology Branch and Water Rights Branch are summarized as follows:

1. All active and cancelled Water Rights files should be reviewed to determine the water uses that have occurred and that are occurring. Water Rights Branch will provide a listing of active and cancelled files to obtain the necessary details on dates and operations, etc.

2. Using hydrometric records and historical water use data, the natural flows for Piapot and Bear Creeks should be determined for their periods of record. Using hydrometric data or natural flows determined for adjacent basins, a historic record of natural flows should be determined for the period 1912 to the present.

3. Net evaporation data should be determined for the basin using meteorological data collected in the basin or in adjacent basins.

4. Using the historical natural flows and existing uses and storages, the available water should be determined. Locations where water is available for future demand should be determined to help identify potential future development.

5. The Bigstick Lake Basin Water Supply Study (Pentland and Moser, 1977) should provide a general guide to the study with due recognition for the smaller basin size and the modest water storage facilities available in the Crane Lake Basin.

6. The results of the Crane Lake Basin water supply study should be documented in a standard detailed Hydrology Branch report.

To assist in evaluating the available water supply under various demands and conditions of operation, Water Rights Branch provided supplementary information and posed additional clarifying questions in an August 21, 1978 memo. The additional information from this memo is summarized as follows:

1. When natural flows have been reconstructed at the Water Survey of Canada (WSC) hydrometric stations on Piapot and Bear Creeks the median and 70 per cent available natural flow at each station should be determined.

2. Since the amount of water diverted does not always agree with the quantity which has been appropriated, the available water supply should be determined under several conditions of demand. The various demands should be evaluated using the following options:

(i) diversion reflected by existing water rights licences or authorizations;

(ii) a high estimate of actual diversion; and

(iii) a low estimate of actual diversion.

3. Tables 1 and 2 present a list of projects and associated diversions for Piapot Creek and Bear Creek respectively, as per the criteria listed in 2(i) to 2(iii) above for calculating the available water supply. Projects which do not appear in the tables do not require adjustment since diversion in each case is reflected by water rights licences or authorizations.

4. Considering the demand alternatives listed in No. 2 above, the available water supply should be determined at:

(i) the WSC station on Bear Creek based on (a) median natural flow and (b) 70 per cent availability of natural flow;

(ii) the WSC station on Piapot Creek based on (a) median natural flow and (b) 70 per cent availability of natural flow;

(iii) the diversion point of the Needham project (Water Rights File 75) on Bear Creek based on median natural flow;

(iv) SW 18-12-23-3 for Bear Creek above the confluence with Piapot Creek based on median natural flow;

(v) the diversion point of the Weiss project (Water Rights File 9802) on Piapot Creek based on median natural flow; and

(vi) SW 18-12-23-3 for Piapot Creek above the confluence with Bear Creek based on median natural flow.

Table 1 - ESTIMATED DIVERSIONS FOR PROJECTS ON PIAPOT CREEK

Project Owner	Water Rights File No.	Licensed Diversion		High Estimate		Low Estimate	
		Irrigated Area (hectares)	Diversion (dam^3)	Irrigated Area (hectares)	Diversion (dam^3)	Irrigated Area (hectares)	Diversion (dam^3)
Moorhead	13	121.4	555	40.5	123	20.2	41
Beveridge	15	16.2	49	16.2	49	16.2	33
Moorhead	66	63.9	195	20.2	62	0	0
Moorhead	67	40.5	185	20.2	62	0	0
Moorhead	136	25.1	76	25.1	76	25.1	51
Beveridge	146	89.0	271	89.0	271	89.0	180
Beveridge	163	110.9	226	110.9	226	110.9	226
Beveridge	184	22.3	46	22.3	46	22.3	46
Weiss	9802	46.5	95	24.3	49	24.3	49

Table 2 - ESTIMATED DIVERSIONS FOR PROJECTS ON BEAR CREEK

Project Owner	Water Rights File No.	Licensed Diversion		High Estimate		Low Estimate	
		Irrigated Area (hectares)	Diversion (dam^3)	Irrigated Area (hectares)	Diversion (dam^3)	Irrigated Area (hectares)	Diversion (dam^3)
Needham	11	72.8	333	72.8	222	72.8	148
Needham	75	367.5	1680	242.8	740	121.4	247
Bowie	84	319.7	1462	319.7	974	242.8	493
Unsworth	171	17.4	53	17.4	53	17.4	53
Sanderson	348	17.0	52	17.0	52	17.0	52

CHAPTER II

METHODOLOGY

A. GENERAL

The methodology used for this study is based on the study method of the Bigstick Lake study. The Crane Lake Basin was divided into seven smaller sub-basins, and the water supply for each sub-basin was analyzed separately assuming no interconnections. Natural historic flows were used in conducting the water supply studies. Historic natural flow data from the Bigstick Lake study were used for correlations to determine historic natural flows for the Crane Lake Basin.

B. DRAINAGE AREAS

Figure 2 shows the Crane Lake Basin sub-divided into seven sub-basins. These sub-basins were determined based on the locations for water availability requested by the Water Rights Branch. The sub-basins are as follows:

Sub-basin 1 - Piapot Creek and all its tributaries to the hydrometric station Piapot Creek near Piapot.

Sub-basin 2 - Bear Creek and all its tributaries to the hydrometric station Bear Creek near Piapot.

Sub-basin 3 - Piapot Creek and local inflow from the hydrometric station Piapot Creek near Piapot to the Water Rights licensed project WR 9802.

Sub-basin 4 - Bear Creek and local inflow from the hydrometric station Bear Creek near Piapot to the Water Rights licensed project WR 75.

Sub-basin 5 - Piapot Creek and local inflow from Water Rights licensed project WR 9802 to the confluence of Piapot and Bear Creeks.

Sub-basin 6 - Bear Creek and local inflows from Water Rights licensed project WR 75 to the confluence of Piapot and Bear Creeks.

Sub-basin 7 - Piapot Creek and local inflow from the confluence of Piapot and Bear Creeks to Crane Lake including Crane Lake and all local inflow into Crane Lake.

Drainage areas were delineated using 1:50,000 National Topographic Maps and the most current air photos. Only the gross drainage areas and dry drainage areas were delineated.

The gross drainage area of a stream at a specified location is that area, enclosed by its drainage divide, which might be expected to entirely contribute runoff to that specified location under extremely wet conditions.

The dry drainage area is that portion of a drainage basin which might be expected to entirely contribute runoff to the main stream during periods of low precipitation, say, the one in two year flood. This area excludes marsh and slough areas and other natural or artificial storage areas which would prevent runoff from reaching the main stream in an average year.

Table 3 provides the drainage areas for the Crane Lake Basin.

C. WATER RIGHTS

A major assessment of the water rights in the Crane Lake Basin was undertaken. A computer printout of all active and cancelled Water Rights Branch files for Crane Lake to date (1982) was obtained and all files were reviewed to determine dates of authorization, licence and first diversion as well as the volume of

water licensed for diversion and the estimated volume of actual diversions. The results are contained in Appendix I attached hereto, and summarized in Table 4. All projects are located in the dry drainage area of the basin.

D. HYDROMETRIC DATA

Hydrometric data has been collected at two stations by Water Survey of Canada. These stations are Piapot Creek near Piapot (STA 05HA062) and Bear Creek near Piapot (STA 05HA003) and are shown on Figure 2. Piapot Creek near Piapot has 12 years of data for the years 1916, 1919 and 1963 to 1972 inclusive. Bear Creek near Piapot has 32 years of data for the years 1916, 1919 to 1930 inclusive and 1963 to the present. Both hydrometric stations are representative of the drainage areas from the Cypress Hills slopes.

To convert the recorded flows for the two hydrometric stations to natural flows, the estimated actual volumes of flow used by the licensed and authorized Water Rights projects in the respective drainage basins were added to the recorded flows. The estimated actual volumes of flow used by the licensed and authorized Water Rights projects are contained in Appendix I. Since the Water Rights projects are all located in the dry drainage areas of the hydrometric stations, the entire volume used was added to the recorded flows.

The natural flows for the two hydrometric stations were then extended to the year 1911 by correlating to one another and/or correlating to those sub-basins in the Bigstick Lake Basin which best represented the drainage areas of Bear Creek near Piapot and Piapot Creek near Piapot. Table 5 shows the results of the correlations and the correlating data used to extend the hydrometric records.

The natural historic flows for Piapot Creek near Piapot and Bear Creek near Piapot represent the natural historic flows for sub-basins 1 and 2 respectively, and are representative of drainage areas from the Cypress Hills slopes. They would not, however, be representative of the drainage areas of the flatter prairie sub-basins of the Crane Lake Basin. Therefore, natural historic flows were determined for sub-basins 3 to 7 of the Crane Lake Basin, based on the natural historic flows of representative sub-basins of the Bigstick Lake study. Sub-basins 10, 11 and 12 of the Bigstick Lake study were found to be the most representative of the drainage areas for sub-basins 3 to 7 in the Crane Lake Basin.

The data for sub-basins 10, 11 and 12 from the Bigstick Lake study were extended to the present by correlating to other hydrometric stations in the vicinity of the Bigstick Lake Basin. Table 5 shows the results of these correlations and the correlating station used to extend the natural historic flows.

Once the flows were extended to the present, they were transferred to the Crane Lake sub-basins by means of drainage area ratios. Basic to this is the assumption that in a 1:2 event the dry drainage area contributes to the runoff, in a 1:1000 event the gross drainage area contributes to the runoff, and that in the intermediate events the contributing drainage area varies in direct proportion to the plotting position on Gumbel extreme value probability paper.

Table 3 - CRANE LAKE BASIN DRAINAGE AREAS

Sub-basin	Areas km^2	
	Dry	Gross
1	125	125
2	247	247
3	54.0	71.0
4	31.2	31.2
5	23.0	33.2
6	40.5	64.9
7	199	297
Total	720	869

Table 4 - CRANE LAKE BASIN LICENSED AND AUTHORIZED EXISTING (1982) WATER RIGHTS USES

Sub-basin	Irrigation Uses (dam^3)	Domestic Uses (dam^3)
1	2129	55
2	1057	75
3	745	91+
4	1912	45
5	0	27
6	1842	56+
7	668	80+
Total	8353	429

+ includes Ducks Unlimited project(s).

Table 5 - HYDROMETRIC DATA CORRELATIONS

Station to Have Record Extended	Correlating Station	Coefficient of Correlation	Standard Deviation (dam^3)	Coefficient of Variance %	Years of Data Used
Bear Creek Near Piapot	Sub-basin 5, Bigstick Lake	0.92	1963	18.2	-
	Sub-basin 10, Bigstick Lake	0.94	1677	15.6	1911-1915, 1917 1918, 1931-1962
	Sub-basin 11, Bigstick Lake	0.94	1713	15.9	-
Piapot Creek Near Piapot	Bear Creek near Piapot	0.87	1343	33.7	1973-1981
	Sub-basin 5, Bigstick Lake	0.86	1425	35.8	-
	Sub-basin 10, Bigstick Lake	0.85	1440	36.1	-
	Sub-basin 11, Bigstick Lake	0.88	1309	32.9	1911-1915, 1917 1918, 1920-1962

Table 5 (continued)

Station to Have Record Extended	Correlating Station	Coefficient of Correlation	Standard Deviation (dam^3)	Coefficient of Variance %	Years of Data Used
Sub-basin 10 Bigstick Lake	Bear Creek near Piapot	0.94	91	24.1	1975-1981
	Swift Current Creek below Rock Creek	0.94	101	27.7	-
	Bridge Creek at Gull Lake	0.87	139	30.6	-
Sub-basin 11 Bigstick Lake	Bear Creek near near Piapot	0.94	285	27.9	1975-1981
	Swift Current Creek below Rock Creek	0.94	339	34.5	-
	Bridge Creek at Gull Lake	0.89	402	32.3	-
Sub-basin 12 Bigstick Lake	Bear Creek near Piapot	0.93	256	32.7	1975-1981
	Swift Current Creek below Rock Creek	0.90	414	52.4	-
	Bridge Creek at Gull Lake	0.90	347	35.8	-

E. EVAPORATION DATA

Net evaporation data for the Crane Lake Basin was calculated based on monthly gross evaporation data for Swift Current as determined by PFRA (PFRA, Department of Regional Economic Expansion, 1982). Data for the months of April to October for the period 1911 to 1981 was used. The Swift Current data was transposed to the Crane Lake Basin using an adjustment factor determined from the Prairie Provinces Water Board Report No. 5 "Evaporation from Lakes and Reservoirs on the Canadian Prairies" (Prairie Provinces Water Board, 1952). Once the gross evaporation data was transposed to the Crane Lake Basin, it was converted to net evaporation by subtracting the Crane Lake Basin precipitation. Precipitation data was obtained from the Atmospheric Environment Service (AES) of Environment Canada. The AES meteorological stations used are listed in Table 6.

F. WATER SUPPLY STUDIES

Water supply studies were undertaken for all the sub-basins based on the natural flows determined and using the licensed water demand as well as the high and low estimates of actual use.

A frequency analysis was undertaken for each sub-basin, and the results plotted on Gumbel extreme value paper. From the plots, the median annual volumes and 70 per cent available natural flow was determined. The licensed demand and high and low estimates of actual water use were compared to the annual volumes of natural flow to determine the per cent of time shortages would occur.

Table 6 - METEOROLOGICAL STATIONS

Station	AES Station No.	Period of Record
Maple Creek	4024920	1911-1913, 1921-1967 partial 1974-present
Maple Creek North	4024936	1951-present
Swift Current	4028035	1911-1938
Swift Current	4028040	1938-present

CHAPTER III

RESULTS

A. HYDROMETRIC DATA

Table 7 shows the drainage area ratios for the Crane Lake sub-basins compared to the Bigstick Lake sub-basins. The table shows that, assuming a straight line relationship between the dry and gross drainage area ratios on Gumbel extreme value probability paper, the line would have a negative slope. This could result in the rarer events being smaller than the more frequent events. As a result, it is assumed that the hydrometric data can be transferred from the Bigstick Lake sub-basins to the Crane Lake sub-basins on the basis of a constant drainage area ratio; that being the dry drainage area ratio. The error resulting from this assumption is felt to be minimal for two reasons:

1. The majority of the flow for any event will come from the dry drainage area; and

2. The drainage area outside of the dry drainage area may be considered for all intents and purposes as non-effective, that is, these areas can be considered as closed drainage basins within the Crane Lake Basin drainage area.

Sub-basin 11 of Bigstick Lake was felt to be most representative of the drainage areas of sub-basins 3, 4, 5 and 6 of Crane Lake. Sub-basin 12 of Bigstick Lake was felt to be most representative of sub-basin 7 of Crane Lake.

Table 8 shows the historic natural flows for the Crane Lake Basin. By summing the flows of the sub-basins, the total flow for the Crane Lake Basin can be determined.

B. EVAPORATION DATA

Table 9 shows the annual net evaporation for the Crane Lake Basin.

C. WATER SUPPLY STUDIES

The results of the frequency analyses for the seven sub-basins were plotted on Gumbel extreme value probability paper, and shown on Figures 3 to 9 inclusive. For the two hydrometric stations (sub-basins 1 and 2) only the observed values were plotted; estimated data were used only to determine plotting position. For sub-basins 3 to 7, the entire array of historic natural flows were used to develop the frequency curve.

Table 10 shows the results of the water supply study for each sub-basin.

Table 10 shows that based on licensed and authorized Water Rights projects, sub-basins 1, 3, 4 and 6 are overallocated assuming that shortages occurring 30 per cent of the time is acceptable. Furthermore, sub-basins 3, 4 and 6 are overallocated based both high and low estimates of actual diversions by licensed and authorized Water Rights projects.

Only sub-basin 2 experiences no shortages in any year based on natural flows. In fact, Figure 4 shows that on an median annual basis approximately 900 dam^3 could be licensed before shortages would occur.

Sub-basins 5 and 7 do experience shortages, however, they are less than 30 per cent of the time and, therefore there is limited room for further licences in these two sub-basins.

Table 7 - CRANE LAKE/BIGSTICK LAKE DRAINAGE AREA RATIOS

Crane Lake Sub-basins	Bigstick Lake Sub-basins					
	Sub-basin 10		Sub-basin 11		Sub-basin 12	
	Dry	Gross	Dry	Gross	Dry	Gross
3	4.19	2.11	1.74	0.61	2.08	0.16
4	2.42	0.93	1.00	0.27	1.20	0.07
5	1.78	0.99	0.74	0.28	0.89	0.07
6	3.14	1.93	1.30	0.55	1.56	0.15
7	15.4	8.81	6.40	2.54	7.68	0.67

TABLE 8 - CRANE LAKE NATURAL FLOWS

Year	Sub-basin 1 (dam^3)	Sub-basin 2 (dam^3)	Sub-basin 3 (dam^3)	Sub-basin 4 (dam^3)	Sub-basin 5 (dam^3)	Sub-basin 6 (dam^3)	Sub-basin 7 (dam^3)
1911	3860	11700	1840	1060	784	1380	5940
1912	4570	13000	2290	1320	976	1720	7440
1913	2200	7500	787	453	335	590	2470
1914	2360	7930	889	512	379	667	2790
1915	5390	14800	2810	1620	1200	2110	9370
1916	10400	18400	3980	2290	1690	2980	14100
1917	9510	20800	5430	3130	2310	4080	22000
1918	2760	8970	1140	656	485	854	3580
1919	2140	4990	155	89	66	116	484
1920	3560	13400	1650	951	703	1240	5220
1921	3680	11300	1730	995	736	1300	5490
1922	6860	17800	3750	2160	1600	2810	12800
1923	2290	6240	840	484	358	630	2640
1924	1340	3600	240	138	102	180	745
1925	4730	13800	2400	1380	1020	1800	7910
1926	1660	8030	443	255	189	332	1390
1927	9020	21800	5120	2950	2180	3840	19800
1928	2450	10100	946	545	403	710	2970
1929	2960	11200	1270	730	540	951	3980
1930	1840	7580	557	321	237	418	1740
1931	1080	4650	75	43	32	56	238
1932	1490	5590	330	190	141	247	1030
1933	1380	5310	264	152	112	198	822
1934	1470	5520	318	183	135	238	999
1935	1870	6610	576	332	246	432	1810
1936	3970	11700	1910	1100	814	1430	6130
1937	1200	4830	148	85	63	111	461
1938	2840	9180	1190	685	507	892	3730
1939	3800	11500	1810	1040	769	1350	5750
1940	4110	12000	2000	1150	850	1500	6480
1941	2820	9150	1180	678	501	883	3720
1942	2150	7340	750	432	319	563	2360
1943	5580	15200	2930	1690	1250	2200	9830
1944	1810	6460	535	308	228	401	1690
1945	1340	5210	240	138	102	180	745
1946	1770	6370	512	295	218	384	1610

Table 8 - (continued)

Year	Sub-basin 1 (dam^3)	Sub-basin 2 (dam)	Sub-basin 3 (dam^3)	Sub-basin 4 (dam^3)	Sub-basin 5 (dam^3)	Sub-basin 6 (dam^3)	Sub-basin 7 (dam^3)
1947	3420	10700	1560	900	666	1170	4940
1948	2940	9440	1260	724	535	943	3950
1949	1090	4530	76	44	33	57	238
1950	1890	6670	587	338	250	440	1850
1951	7130	17300	3920	2260	1670	2940	13700
1952	8550	19600	4830	2780	2060	3620	18100
1953	6510	17200	3520	2030	1500	2640	11900
1954	3300	10300	1480	855	632	1110	4660
1955	11600	24700	6790	3910	2890	5090	31000
1956	2240	7600	809	466	345	607	2540
1957	2580	8500	1020	590	436	768	3210
1958	2170	7410	764	440	325	573	2400
1959	2800	9080	1160	671	496	874	3360
1960	3580	11200	1660	958	708	1250	5280
1961	1130	4650	104	60	44	78	330
1962	2050	7100	688	396	293	516	2160
1963	1110	7340	580	334	247	435	1820
1964	1790	4960	672	387	286	504	2110
1965	5550	19100	3650	2100	1550	2730	12500
1966	3390	9500	1670	960	710	1250	5290
1967	6780	16200	4460	2570	1900	3350	16300
1968	2480	5890	412	237	175	309	1290
1969	4570	12600	1930	1110	821	1450	6190
1970	4710	14200	2670	1540	1140	2010	8840
1971	3020	9970	2000	1150	850	1500	6500
1972	1860	6990	863	497	368	647	2710
1973	1980	6380	302	174	129	227	945
1974	2800	8200	1960	1130	836	1470	6400
1975	4730	12500	2240	1290	954	1680	7680
1976	2170	6810	689	397	294	517	2050
1977	150	2310	0	0	0	0	0
1978	2130	6720	665	383	283	499	1970
1979	5630	14500	2780	1600	1180	2080	9680
1980	882	3940	0	0	0	0	0
1981	756	3660	0	0	0	0	0

Table 9 - CRANE LAKE BASIN NET EVAPORATION

Year	Net Evaporation (mm)	Year	Net Evaporation (mm)	Year	Net Evaporation (mm)
1911	241.5	1935	402.9	1959	516.2
1912	225.9	1936	643.8	1960	576.2
1913	374.0	1937	663.7	1961	694.1
1914	454.8	1938	383.8	1962	554.7
1915	237.5	1939	287.4	1963	572.4
1916	156.3	1940	403.6	1964	618.6
1917	385.6	1941	530.9	1965	406.4
1918	486.4	1942	260.3	1966	564.7
1919	549.4	1943	665.6	1967	608.8
1920	469.3	1944	541.6	1968	576.6
1921	485.5	1945	467.6	1969	533.3
1922	410.8	1946	461.5	1970	517.9
1923	326.4	1947	504.5	1971	758.3
1924	474.5	1948	532.9	1972	569.3
1925	358.2	1949	683.3	1973	806.4
1926	510.6	1950	265.0	1974	546.0
1927	26.6	1951	264.0	1975	326.3
1928	478.4	1952	488.4	1976	729.0
1929	563.1	1953	491.3	1977	686.9
1930	479.0	1954	273.6	1978	516.7
1931	529.8	1955	393.0	1979	588.0
1932	146.3	1956	467.0	1980	668.5
1933	330.2	1957	463.6	1981	591.4
1934	537.7	1958	557.7	Mean	476.9

Table 10 - CRANE LAKE BASIN WATER SUPPLY

Sub-basin	Volume of flow available (dam^3) 70% of time	50% of time	Volume of flow allocated (dam^3)	Per cent of time shortages occur(1)	High estimate of actual diversions (dam^3)	Per cent of time shortages occur(1)	Low estimate of actual diversions (dam^3)	Per cent of tima shortage occur(1)
1	2000	2750	2184	36.6	1508	16.9	1170	11.3
2	6700	8700	1132	0	1160(2)	0	1143(2)	0
3	550	1100	836	42.3	790	40.8	790	40.8
4	330	620	1957	85.9	1017	66.2	524	46.5
5	250	450	27	4.2	27	4.2	27	4.2
6	450	750	1898	80.3	1299	64.8	744	47.9
7	1900	3700	748	14.1	748	14.1	748	14.1
Total	12380	17670	8782		6549		5146	

(1) Shortages are based on natural flows.

(2) Some licensed users are estimated to be diverting more than allowed by their licence.

CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

Based on the above results, the following conclusions can be made:

1. For sub-basin 1, the median annual natural flow available at the WSC hydrometric station Piapot Creek near Piapot is 2750 dam^3. The annual natural flow available 70 per cent of the time is 2000 dam^3. Shortages in sub-basin 1 can be anticipated almost 40 per cent of the time based on existing Water Rights licences. However, this reduces to almost 10 per cent of the time based on the low estimate of actual diversions. Therefore, sub-basin 1 can be considered to be approaching full allocation. If future licences are to be granted, the water allocated to existing licences may have to be reduced.

2. For sub-basin 2, the median annual natural flow available at the WSC hydrometric station bear Creek near Piapot is 8700 dam^3. The annual natural flow available 70 per cent of the time is 6700 dam^3. Approximately 900 dam^3 median annual natural flow is available for future allocations before shortages may be anticipated, based on existing Water Rights licences.

3. For sub-basin 3, the median annual natural flow available at the diversion point of Water Rights licensed project 9802 on Piapot Creek is 1100 dam^3. The annual natural flow available 70 per cent of the time is 550 dam^3. Shortages in sub-basin 3 can be anticipated more than 40 per cent of the time even based on the low estimate of actual diversions. Therefore, sub-basin 3 can be considered to be fully allocated and no further licences should be considered, since no excess water is available from sub-basin 1.

4. For sub-basin 4, the median annual natural flow available at the diversion point of Water Rights licensed project 75 on Bear Creeek is 620 dam^3. The annual natural flow available 70 per cent of the time is 330 dam^3. Shortages in sub-basin 4, can be anticipated more than 85 per cent of the time based on existing Water Rights licences. Even using the low estimates of actual diversions, shortages can be anticipated almost 50 per cent of the time. Therefore, sub-basin 4 can be considered to be overallocated, and no further licences should be considered without using available water from sub-basin 2.

5. For sub-basin 5, the median annual natural flow available on Piapot Creek at the confluence with Bear Creek is 450 dam^3. The annual natural flow available 70 per cent of the time is 250 dam^3. Shortages in sub-basin 5 can be anticipated approximately 4 per cent of the time. Sub-basin 5 can be considered to be approaching full allocation and the number of future projects that could be licensed will be limited particularly since no excess water is available from upstream.

6. For sub-basin 6, the median annual natural flow available on Bear Creek at the confluence with Piapot creek is 750 dam^3. The annual natural flow available 70 per cent of the time is 450 dam^3. Shortages in sub-basin 6 can be anticipated more than 80 per cent of the time based on existing licences. Even using the low estimate of actual diversions, shortages can be anticipated almost 50 per cent of the time. Sub-basin 6 can be considered to be overallocated, and no further licences should be considered without using available water from sub-basin 2.

7. For sub-basin 7, the median annual natural flow available is 3700 dam^3. The annual natural flow available 70 per cent of the time is 1900 dam^3. Shortages in sub-basin 7 can be anticipated approximately 15 per cent of the time. Therefore, sub-basin 7 can be considered to be approaching full allocation, and the number of future projects that could be licensed will be limited.

8. The mean annual net evaporation for the Crane Lake Basin is estimated to be approximately 477 mm. Net evaporation as high as 758 mm can be anticipated.

B. RECOMMENDATIONS

1. No further water allocations should be made in sub-basin 3.

2. Further water allocations in sub-basins 4 and 6 should only be considered by using available water from sub-basin 2.

3. With the exception of, perhaps, sub-basin 2, the existing Water Rights licences for all the sub-basins should be reviewed to determine whether any can be cancelled before making any future water allocations.

4. A study should be undertaken to determine the feasibility of a series of reservoirs on Piapot Creek and Bear Creek to improve the water availability in the Crane Lake Basin.

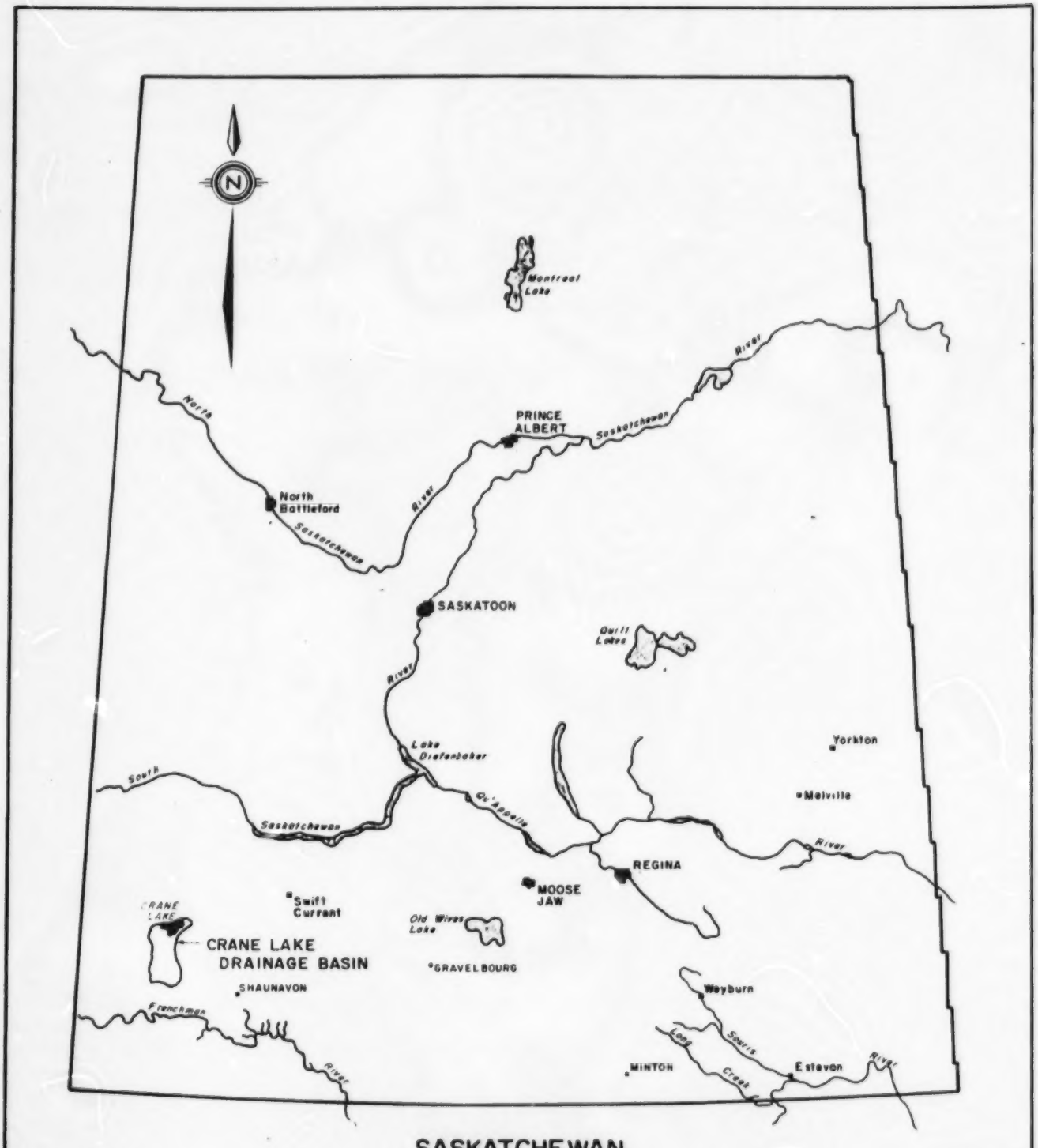
5. If the study of recommendation No. 4 above is going to be undertaken, three hydrometric stations should be established on Piapot and Bear Creeks to assess the hydrology of the prairie area of the Crane Lake Basin more accurately. These hydrometric stations should be operated for a period of no less than 10 to 15 years, and should be located on Piapot Creek and Bear Creek immediately above their confluence and on Piapot Creek immediately above Crane Lake. The hydrometric station Piapot Creek near Piapot should also be reactivated for the same minimum period of 10 to 15 years.

BIBLIOGRAPHY

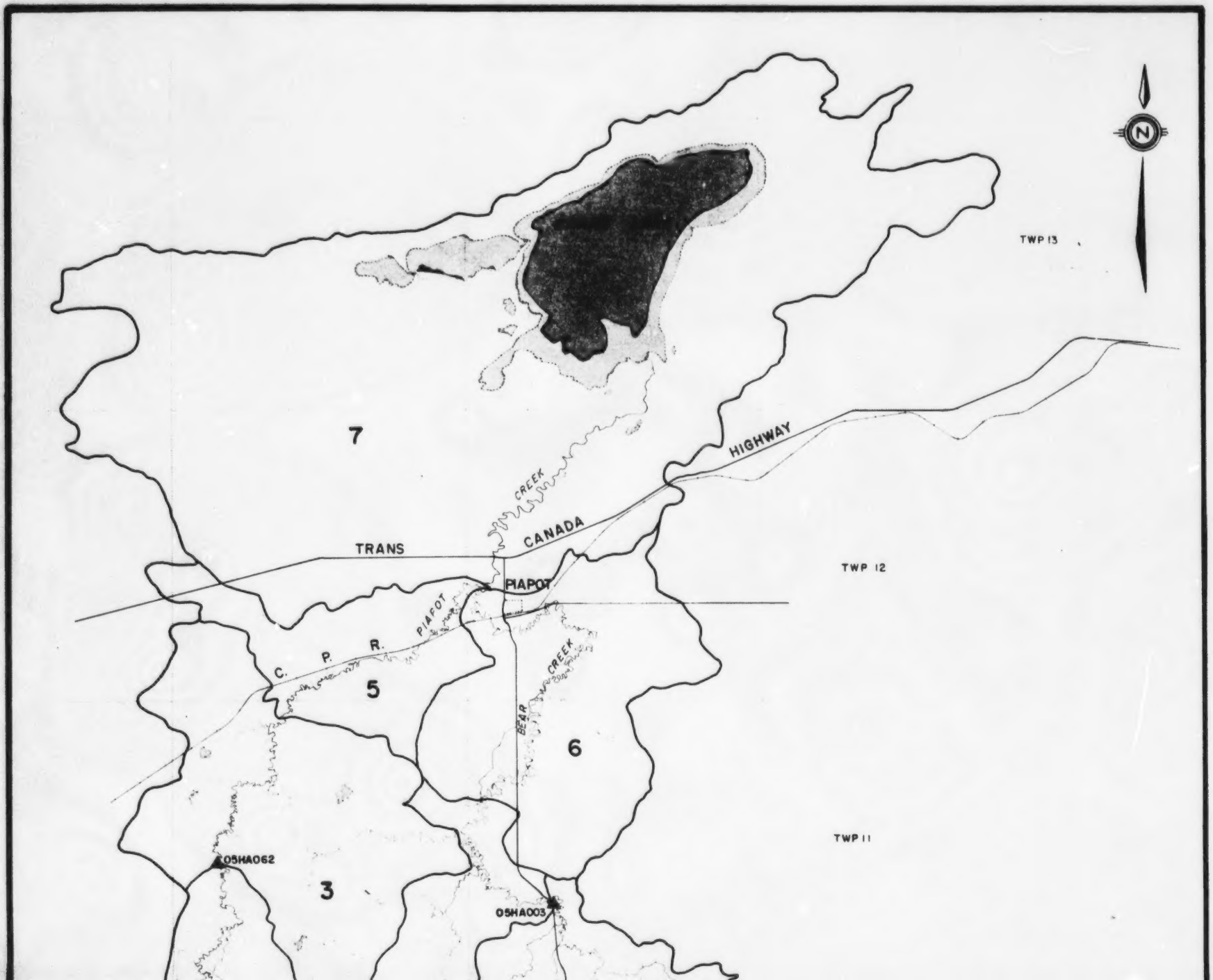
1. "Bigstick Lake Basin Water Supply Study", R. S. Pentland and A. R. Moser, Hydrology Branch, Saskatchewan Environment, September, 1977 (unpublished).

2. "Precipitation and Evaporation Tables 1911-1980", Hydrology Division, PFRA, Department of Regional Economic Expansion, February, 1982.

3. "Evaporation from Lakes and Reservoirs on the Canadian Prairies", Prairie Provinces Water Board Report No. 5, December 1952.



SASKATCHEWAN DEPARTMENT OF THE ENVIRONMENT HYDROLOGY BRANCH		CRANE LAKE BASIN WATER SUPPLY STUDY CRANE LAKE BASIN LOCATION MAP	FIGURE 1
DRN. J. W. W.	DATE DEC. /82		
CK'D	PLAN NO. H3-4(2)		


N
TWP 13
TWP 12
TWP 11
7
6
5
3
HIGHWAY
CREEK
TRANS
CANADA
PIAPOT
PIAPOT
C. P. R.
BEAR
CREEK
05HA062
05HA003

TWP 10

TWP 9

RGE 24

RGE 23 W3M

MILES
0 1 2 3 4 5 6
0 1 2 3 4 5 6 7 8 9 10
KILOMETERS

LEGEND
▲ - HYDROMETRIC STATION
4 - SUB-BASIN NUMBER

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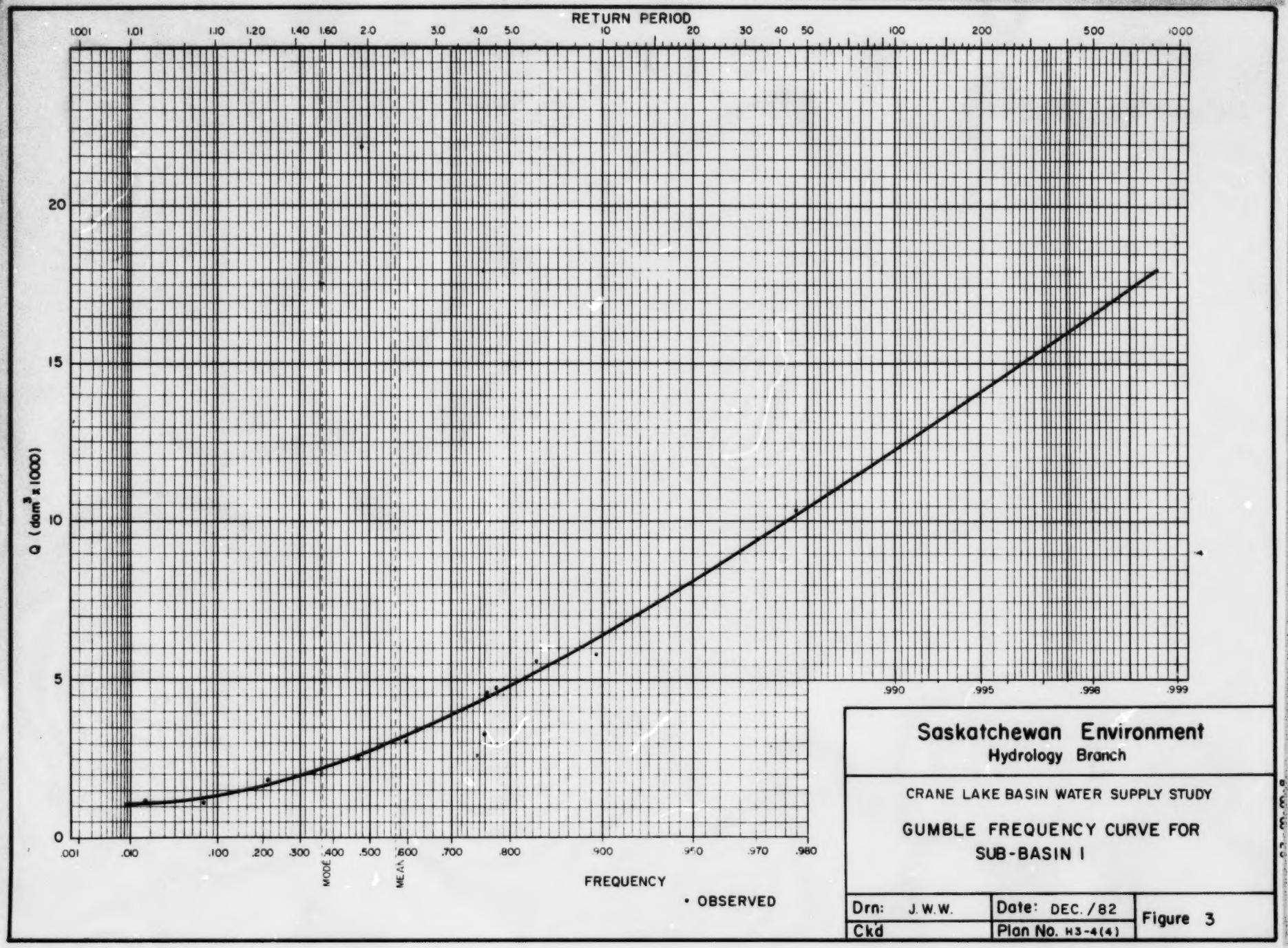
Hydrology Branch

CRANE LAKE BASIN WATER SUPPLY STUDY

CRANE LAKE BASIN SHOWING
SUB-BASINS & HYDROMETRIC NETWORK

Drn J.W.W.	Date DEC /82	Figure 2
Ck'd	Plan No. H3-4(3)	

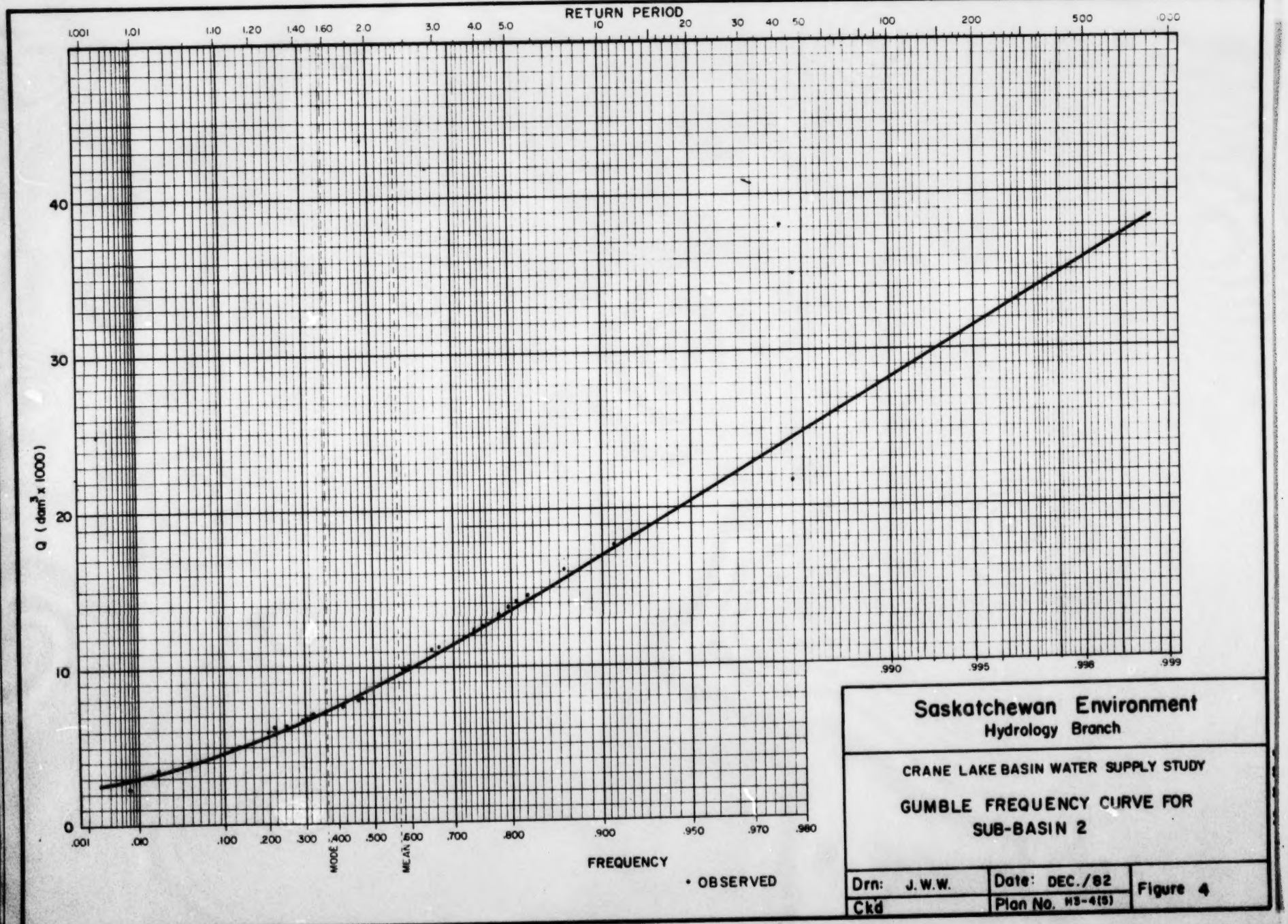


Saskatchewan Environment
Hydrology Branch

CRANE LAKE BASIN WATER SUPPLY STUDY

GUMBLE FREQUENCY CURVE FOR SUB-BASIN 1

Drn: J.W.W.	Date: DEC./82	Figure 3
Ckd	Plan No. H3-4(4)	



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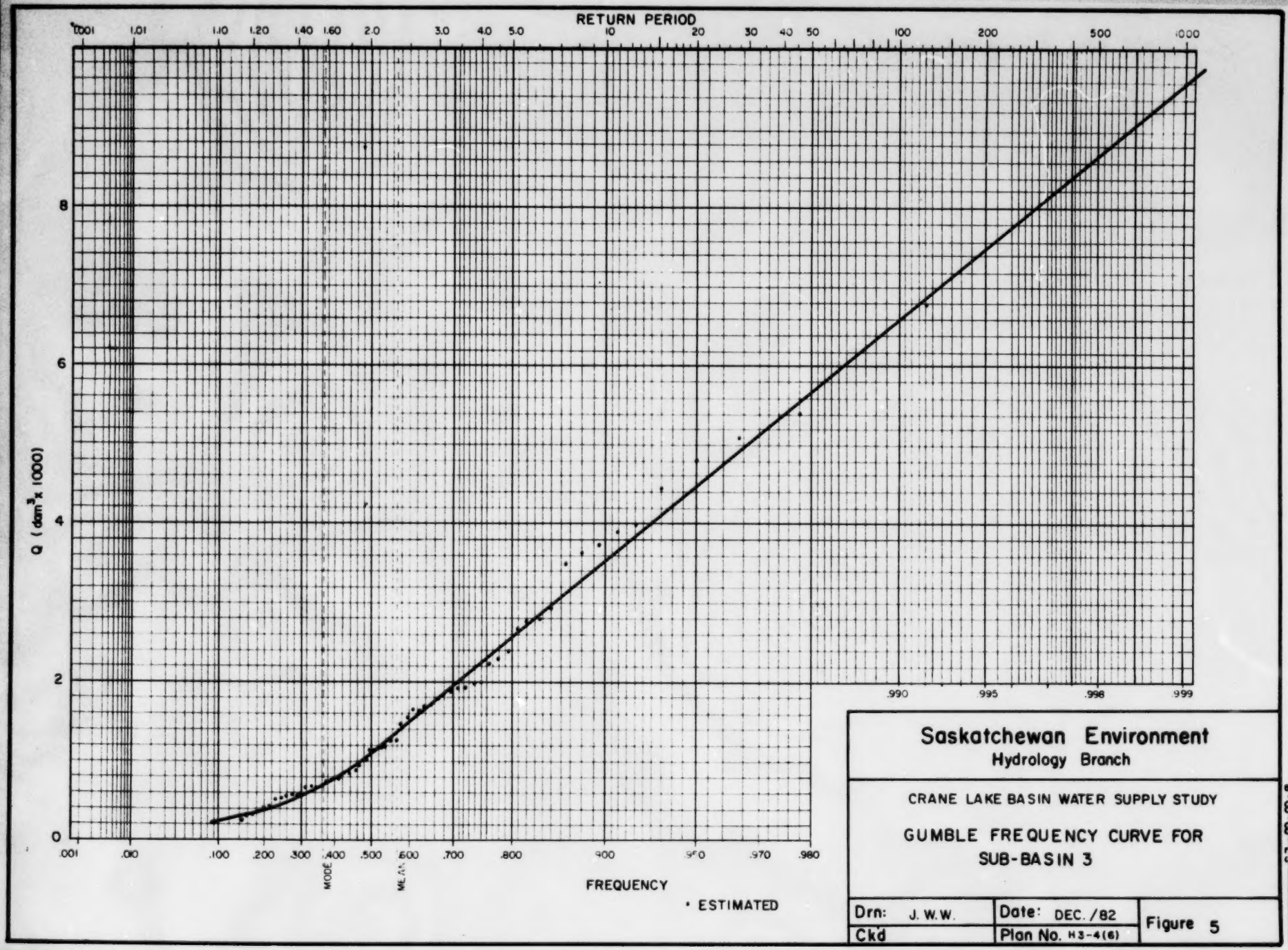
Hydrology Branch

CRANE LAKE BASIN WATER SUPPLY STUDY

GUMBLE FREQUENCY CURVE FOR SUB-BASIN 2

Drn: J.W.W.	Date: DEC./82	Figure 4
Ckd	Plan No. HS-4(S)	



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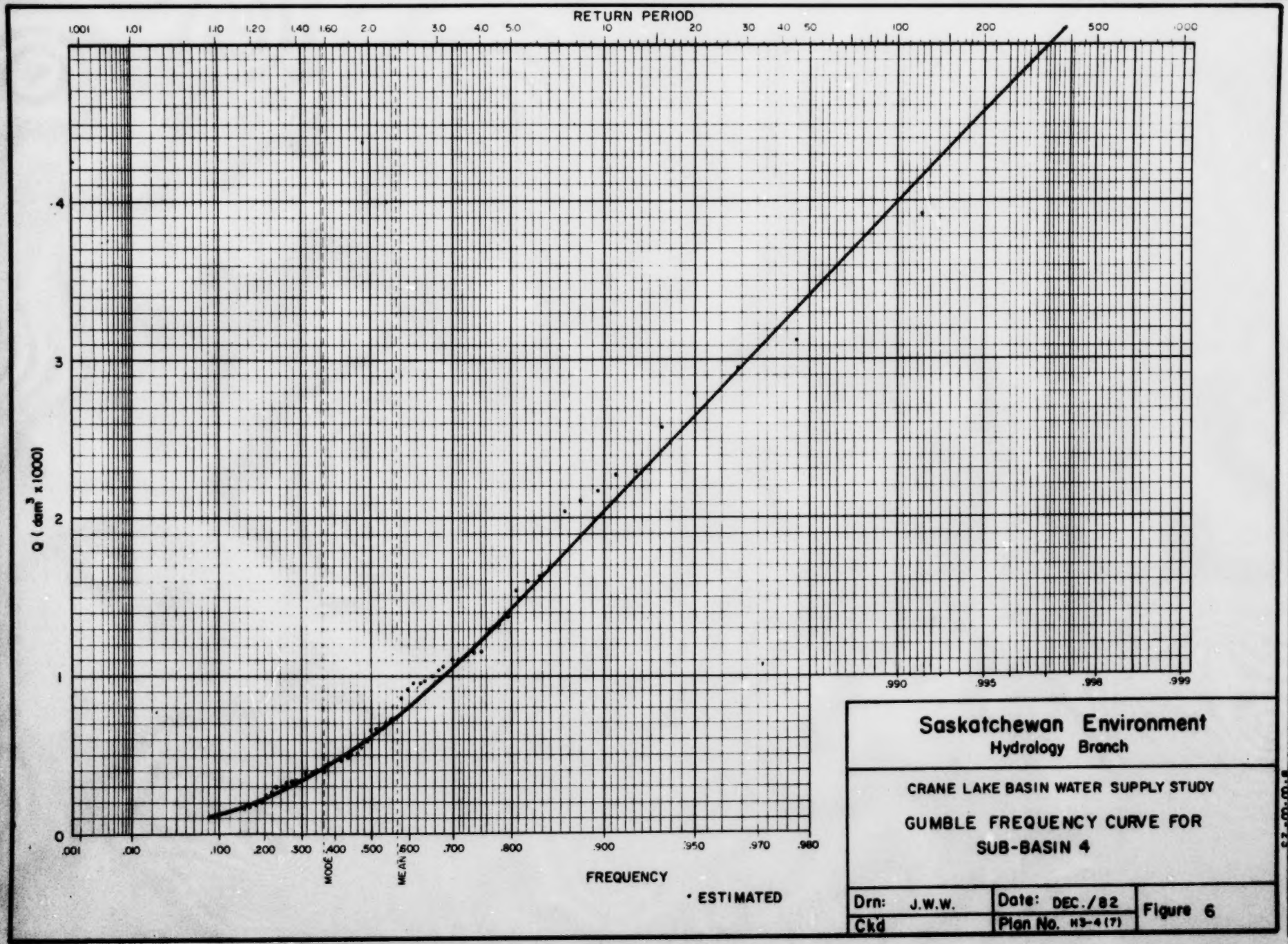
Hydrology Branch

CRANE LAKE BASIN WATER SUPPLY STUDY

GUMBLE FREQUENCY CURVE FOR SUB-BASIN 3

Drn: J. W. W.	Date: DEC. / 82	Figure 5
Ckd	Plan No. H3-4(6)	



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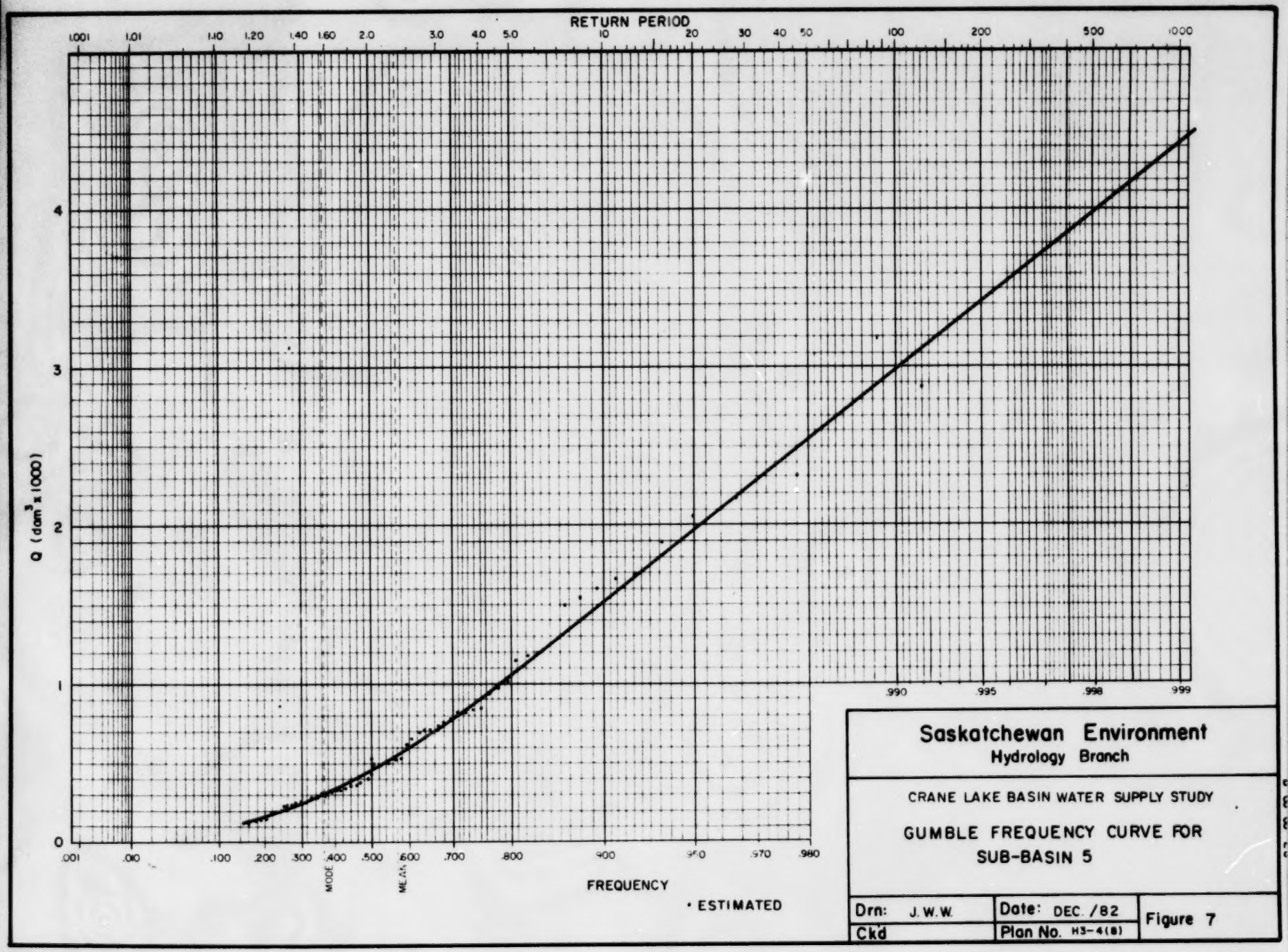
CRANE LAKE BASIN WATER SUPPLY STUDY

GUMBLE FREQUENCY CURVE FOR SUB-BASIN 4

Drn: J.W.W.	Date: DEC./82	Figure 6
Ckd	Plan No. H3-4(7)	



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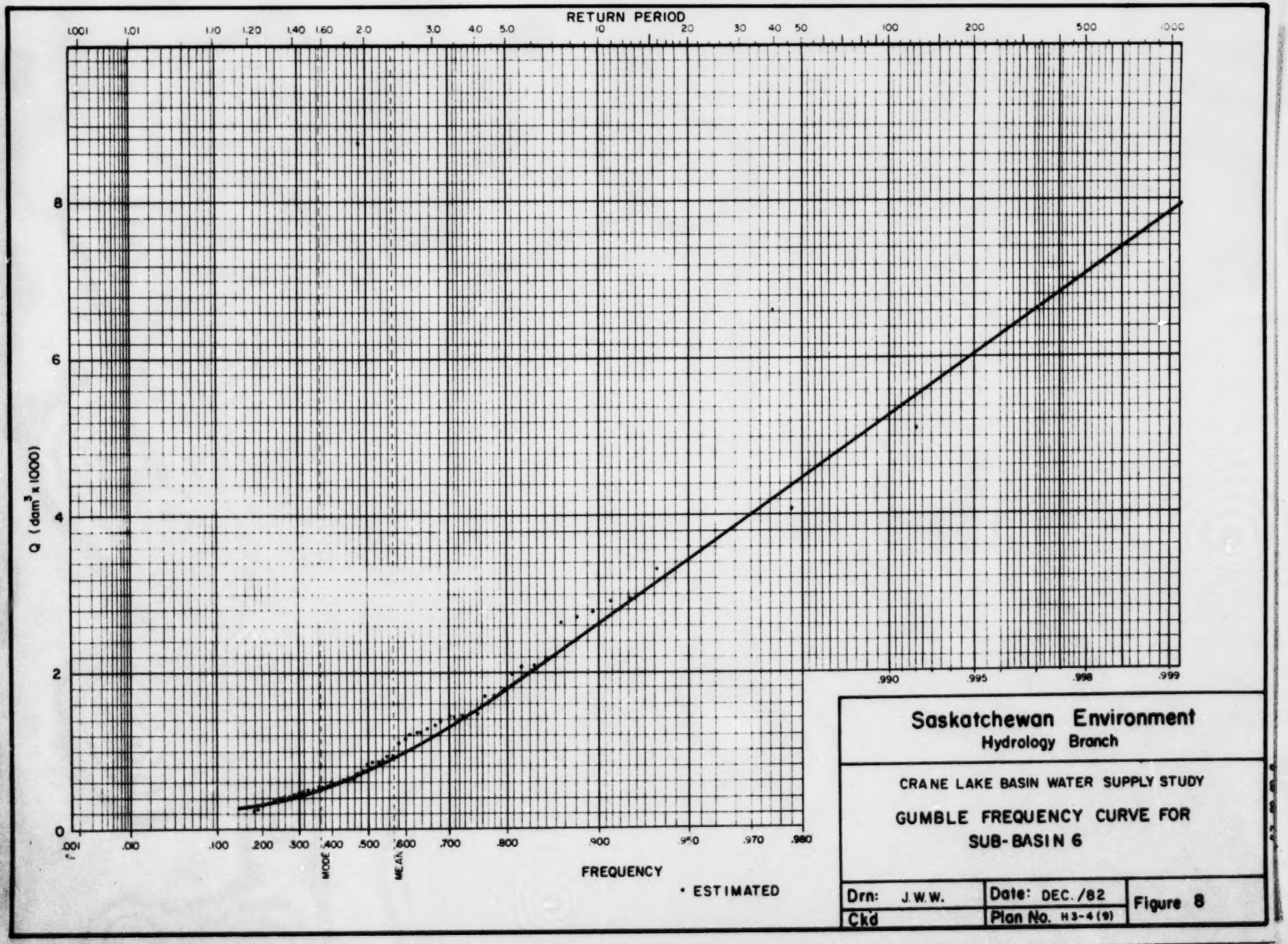
CRANE LAKE BASIN WATER SUPPLY STUDY

GUMBLE FREQUENCY CURVE FOR SUB-BASIN 5

Drn: J.W.W.	Date: DEC./82	Figure 7
Ckd	Plan No. H3-4(8)	



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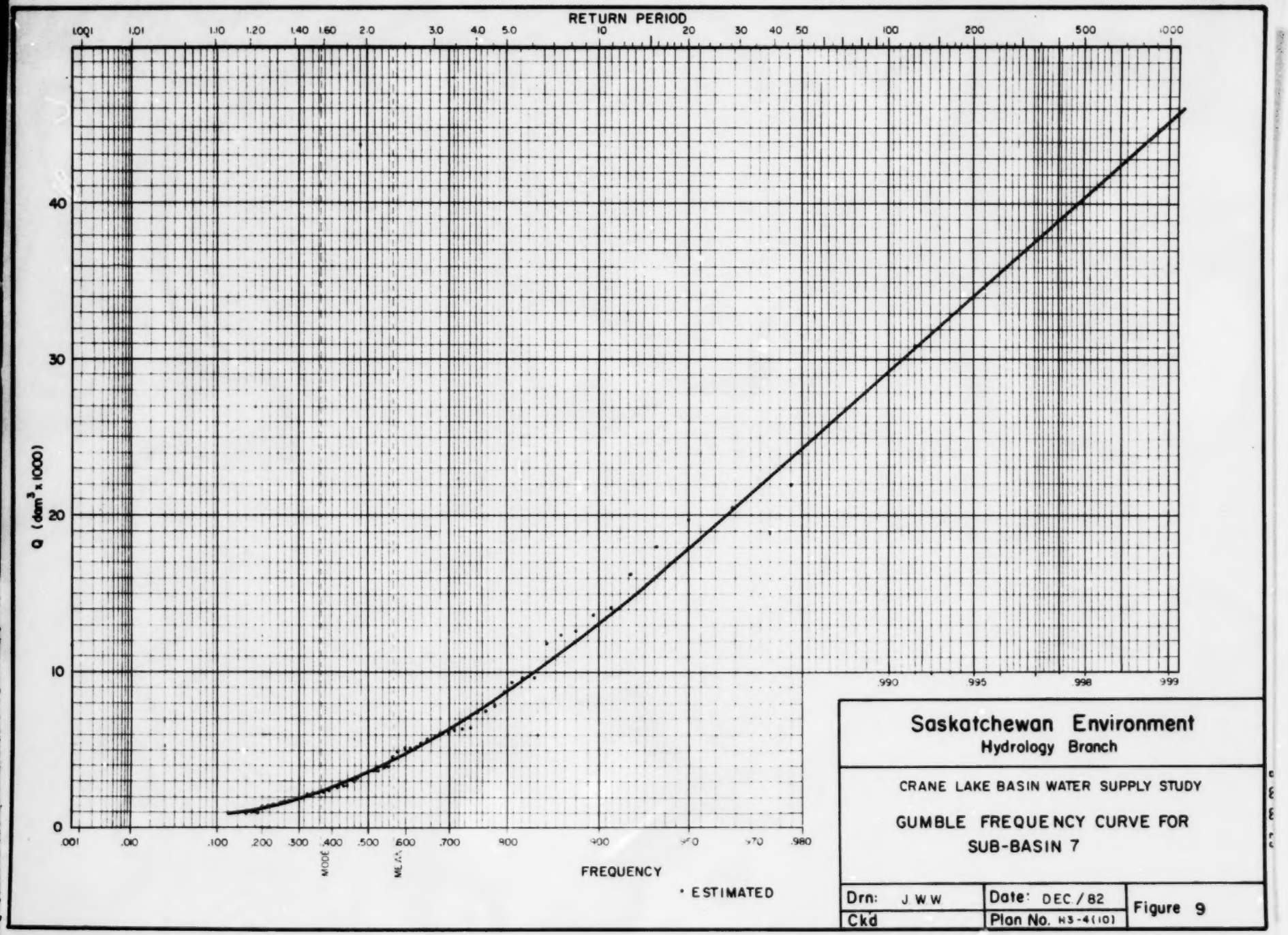
CRANE LAKE BASIN WATER SUPPLY STUDY

GUMBLE FREQUENCY CURVE FOR
SUB-BASIN 6

Drn: J.W.W.	Date: DEC./82	Figure 8
Ckd	Plan No. H3-4(9)	



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CRANE LAKE BASIN WATER SUPPLY STUDY

GUMBLE FREQUENCY CURVE FOR SUB-BASIN 7

Drn: J W W	Date: DEC / 82	Figure 9
Ckd	Plan No. H3-4(10)	

APPENDIX I

WATER RIGHTS OF THE CRANE LAKE BASIN

		Page
A.	WATER RIGHTS WITHIN SUB-BASIN 1	I-1
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G.	WATER RIGHTS WITHIN SUB-BASIN 7	I-9

WATER RIGHTS WITHIN SUB-BASIN 1

Irrigation Uses

File Number	Date of Authorization	Date of Licence	First Diversion	Uses (dam^3) Licensed	Uses (dam^3) Estimated Actual
13	19/10/96	23/09/08	1909	555	250
15	11/12/96	01/09/99	1900	49	25
16	17/09/97	25/04/10	1910	131	131
66	01/09/04	10/07/20	1910	195	50
67	31/03/09	27/06/20	1910	185	41
85	25/02/05	27/06/20	1909	247	41
136	31/03/09	10/06/15	1910	76	51
146	17/10/08	27/01/14	1915	271	41
163	13/04/10	28/11/13	1914	226	111
184	Transferred	from No. 163	1975	46	46
1604	09/03/39	07/05/48	1945	36	47 (36 dam^3 to 1968)
1863	27/06/40	-	1941	12	12
1864	12/09/42	30/03/54	1954	10	8
3448	08/04/40	16/06/44	1941	1	0
6039	21/03/52	04/08/61	1953	12	12
6261	20/03/54	18/04/62	1955	12	12
6423	20/11/51	22/07/54	1954	2	2
10950	16/09/69	02/01/73	1973	20	20
13803	25/08/80	-	1982	43	43

Domestic Uses

File Number	Date of Authorization	Licence	First Diversion	Uses (dam^3) Licensed	Estimated Actual
649	01/02/38	22/10/42	1943	2	2
5147	25/11/47	15/08/51	1952	5	5
5712	31/03/50	04/12/51	1952	2	2
6348	05/09/51	13/01/56	1956	2	2
6448	18/03/52	18/01/56	1956	2	2
6449	26/03/52	28/12/56	1957	5	12
6458	14/01/52	28/07/54	1955	1	1
7337	30/12/57	28/03/58	1958	5	9
7338	15/04/58	31/08/59	1960	4	5
8598	11/04/61	14/12/65	1965	2	2
9058	06/03/62	28/10/63	1964	2	2
9281	02/05/62	08/11/63	1964	2	2
13664	18/02/80	-	1980	5	5
13682	04/09/79	-	1982	4	4
13747	27/08/79	project not completed		4	
14526	22/04/82	project not completed		5	
14527	14/05/82	project not completed		3	

Cancelled Files

File No.	Date of First Diversion	Date of Cancellation	Licensed Use	Estimated Actual Use
50877	no file information		-	-
53355	1952 (authorized)	1954	-	-
53356	1952 (authorized)	1954	-	-
53357	1952 (applied)	1955	-	-
53361	1955 (applied)	1961	-	-

WATER RIGHTS WITHIN SUB-BASIN 2

Irrigation Uses

File Number	Date of Authorization	Date of Licence	First Diversion	Uses (dam^3) Licensed	Uses (dam^3) Estimated Actual
348	29/06/21	30/04/58	1926	52	35
463	03/05/26	12/12/57	1930	64	50
469	08/03/27	11/10/68	1930	27	27
2178	03/02/39	27/11/39	1940	4	4
5246	03/11/50	22/03/61	1951	17	17
5689	20/03/51	05/10/53	-	6	0
6008	31/03/67	31/03/67	1955	15	15 ($9\ dam^3$ to 1962)
6009	14/04/52	20/12/65	1966	7	7
6146	31/08/53	10/06/70	1969	44	44
6747	24/10/56	30/04/57	-	10	0
7651	24/04/62	28/05/64	1964	27	27
8119	25/07/68	25/06/74	1974	7	7
8120	25/07/68	25/07/68	1978	25	25
8500	06/04/62	17/12/65	1964	22	22
9301	17/04/62	11/06/64	1964	14	14
9630	26/09/63	31/03/67	1965	9	9
10501	25/06/75	02/02/76	1969	26	26
10531	18/07/66	10/06/68	1967	7	7
10707	17/11/69	19/11/69	1966	27	27
11124	21/07/70	21/09/70	1969	54	54
11359	24/04/70	24/04/70	1969	15	15
11404	12/12/69	12/12/69	1969	35	35
11520	29/09/70	30/12/70	1969	33	33
11812	28/03/72	08/12/72	1973	25	25
12462	26/04/74	14/11/77	1978	58	58
12464	25/02/75	14/11/77	1978	80	80
12630	06/02/75	19/05/81	1982	68	68
13424	28/02/79	14/05/81	1981	9	9
13683	22/10/79	-	1982	25	25
13726	08/01/80	project not complete		22	
13741	18/12/80	project not complete		69	-
13764	07/01/80	project not complete		25	-
13789	07/01/80	project not complete		25	-
13797	19/12/80	project not complete		23	-
14081	23/03/81	project not complete		26	-
14092	17/12/80	-	1981	14	14
14295	08/07/81	-	1982	36	36
14296	21/07/81	project completed 1982		5	-
14635	project not authorized			-	-

Domestic Uses

File Number	Date of Authorization	Date of Licence	First Diversion	Uses (dam^3) Licensed	Uses (dam^3) Estimated Actual
1951	03/02/39	15/03/39	1939	1	1
2355	29/09/38	17/04/39	1939	2	2
4840	17/10/47	12/08/49	1950	2	30
5048	10/02/48	30/09/49	1950	1	1
5281	23/06/52	25/03/55	1955	2	2
5282	30/01/50	24/02/50	1950	5	5
6007	03/11/50	12/12/57	1958	4	4
6189	24/04/51	31/03/55	1955	5	5
6401	20/11/51	10/06/81	1953	2	2
7063	22/07/69	26/07/71	1962	1	1
7814	20/07/59	24/03/60	1960	2	2
9407	07/12/62	28/10/63	1964	5	5
9595	07/02/63	28/10/63	1964	4	4
9923	18/02/64	04/08/64	1965	5	5
10167	08/02/65	10/06/68	1965	2	2
10434	07/04/66	23/03/67	1965	9	9
11400	12/08/69	26/07/71	1972	4	4
12456	12/06/74	project not complete		6	
12459	12/06/74	project not complete		2	
13106	06/05/77	29/06/77	1978	2	2
13550	04/12/78	09/02/79	1979	1	1
13667	24/08/79	06/06/80	1981	2	2
13862	04/09/79	28/08/80	1981	5	5
14446	13/11/81	project not complete		1.2	

Cancelled Files

File No.	Date of First Diversion	Date of Cancellation	Licensed Use	Estimated Actual Use
50052	no file information		-	-
50876	no file information		-	-
53342	1939	1961	1	0
53344	-	1950	0	0
53348	-	1955	0	0
53350	-	1956	0	0
53351	-	1951	0	0
53352	-	1956	0	0
53353	-	1951	0	0
53354	-	1953	0	0
53358	-	1957	0	0
53359	-	1958	0	0
53362	-	1961	0	0
53363	-	1969	11	0

WATER RIGHTS WITHIN SUB-BASIN 3

Domestic Uses

File Number	Date of Authorization	Date of Licence	Licensed Use (dam^3)
6675	10/03/54	26/05/54	4
9285	23/03/62	02/06/64	7
12023	03/04/72	10/01/77	4
12959	04/06/76	31/08/76	4
13399	25/05/78	19/06/78	4

Irrigation Uses

1601	08/03/39	17/06/64	10
7160	24/06/58	31/05/60	74
7990	24/01/64	17/06/64	15
9802	16/07/63	03/06/76	95
10048	30/04/64	28/02/78	15
10566	18/07/66	25/03/76	11
12536	30/01/75	24/02/76	15
12676	25/08/75	10/01/77	6
14063	22/06/81	project complete	504

Ducks Unlimited

8499	27/05/75	27/05/75	68

WATER RIGHTS WITHIN SUB-BASIN 4

Domestic Uses

File Number	Date of Authorization	Date of Licence	Licensed Use (dam^3)
712	07/11/35	27/05/38	4
913	25/08/37	18/07/38	1
1533	13/01/38	20/04/38	2
1672	19/01/38	10/06/81	2
2912	05/04/39	21/10/69	4
6077	03/04/51	05/09/56	6
9057	04/07/62	02/06/64	2
9860	05/11/63	23/03/67	5
11462	10/09/70	19/01/71	4
11645	09/11/70	29/01/71	4
12886	06/08/76	08/10/76	5
13768	12/09/79	project not complete	1
13920	22/09/80	22/09/80	5

Irrigation Uses

75	13/10/04	18/11/16	1680
171	19/09/10	05/06/81	53
8154	29/01/62	12/08/63	83
11917	17/03/72	11/12/72	28
11992	14/08/72	11/12/72	23
13636	22/06/79	09/10/81	21
14474	07/04/82	project not completed	24

WATER RIGHTS WITHIN SUB-BASIN 5

Domestic Uses

File Number	Date of Authorization	Licence	Licensed Use (dam^3)
8340	17/02/61	project complete	12
8859	09/03/62	28/10/63	15
14581	project complete but not authorized		

Irrigation Uses

N/A

WATER RIGHTS WITHIN SUB-BASIN 6

Domestic Uses

File Number	Date of Authorization	Date of Licence	Licensed Use (dam^3)
1612	13/12/37	23/03/67	10

Irrigation Uses

11	11/12/96	27/12/20	330
84	26/01/05	29/11/60	1462
6250	16/04/51	27/09/54	20
9007	30/01/62	04/06/64	27

Ducks Unlimited

12131	30/04/73	25/06/74	46

WATER RIGHTS WITHIN SUB-BASIN 7

Domestic Uses

File Number	Date of Authorization	Date of Licence	Licensed Use (dam^3)
N/A			

Irrigation Uses

9431	14/01/74	14/01/74	556
10170	31/03/67	31/03/67	112

Ducks Unlimited

14163	14/08/81	project completed	80